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The Impact of EU Regional Support on Growth and Employment

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Abstract

In this paper we assess the impact of structural funds on the per capita GDP and employment convergence process of 145 European regions over 1989–1999. This paper goes beyond the recent contributions on European regional policies and convergence since each of the five objectives of regional support is studied and spatial effects are included in the analysis. For this purpose we use spatial econometrics to include the relevant spatial effects in the estimation of the appropriate conditional β-convergence model. The impact of the funds and their spatial lag indicate few significant results, and when they are, their extent is very small or even negative. This raises some doubts on the efficiency of regional support and call for a deep reform for the next programming period.

1. Introduction

Regional development policies find their origin in the different phases of European integration. Each enlargement, and more especially the one to Greece in 1981 and the one to Spain and Portugal in 1986, has increased per capita GDP disparities among member states, which has, thereafter, given rise to a new solidarity instrument. Indeed, regional development differences can not be passively accepted by European authorities because of equity grounds and common policies. From an equity perspective, the European Commission does not tolerate that agents having similar characteristics may receive different incomes only because they live in different places. From an integration and common policy perspective, installing the Common Market necessitated new transport infrastructures in order to facilitate free circulation of goods and labor all over the territory. In addition, a certain level of convergence was required before introducing the common currency. For the least developed countries, it meant that heavy investments were necessary, but under the constraint of a reduced public debt and deficit. The only solution was therefore to develop the appropriate instruments of solidarity.

More recently, the evaluation of regional development policies has known a tremendous renewed interest for two reasons. First, on the eve of a deep reform and negotiations on European budget perspectives over 2007–2013, the usefulness and the existence itself of these policies have been questioned by some economists, including the authors of the Sapir report (Sapir et al., 2003), which was given a lot of media coverage. They estimate that the direct costs of funds are too high (one-third of the EU budget is devoted to regional policies) and underline the fact that funds tend to reduce the agglomeration process, and thus harm global growth. Second, the recent enlargement to ten countries of Central and Eastern Europe, of which per capita GDP level is much lower than that of the EU15 members, challenges regional policies in an unprecedented way. Their integration has statistically reduced the average Community per capita GDP by 13 % (European Commission, 2003). Their allocation after 2007 will be more complicated since it will have to consider the development gap of not only the poor regions of the EU15, but also nearly all the regions of the new members.

In order to debate on the suitability of regional policies, this paper focuses on the 1989–1999 period during which cohesion efforts have been formally set up and developed, and because more recent data do not exist. In addition, we pay special attention to the geographical localization of each assisted region and the existence of potential linkages between them. More precisely, our paper differentiates itself from the numerous studies on regional income convergence that have followed the famous works of Barro and Sala-I-Martin (1991, 1995)[1] which are based on the same underlying hypotheses as the ones used in international convergence estimation. Indeed, we do not accept to consider regions as isolated entities. As a result, we resort to spatial econometrics to formally include the relevant spatial effects. The choice of this technique is reinforced by the fact that regional funds are at the origin of numerous externalities among regions. Indeed, the major part of these funds finance transportation infrastructures that influence the firm localization process and favor agglomeration in the rich regions (Venables, Gasiorek, 1999), (Vickerman et al., 1999). These spatial effects are not included in most of the studies on the impact of regional policies. However, a noticeable exception is the recent work by Dall'erba and Le Gallo (2007) who conclude to a non-significant impact of the funds on regional growth.

This paper proceeds as follows: Section 2 gives an overview of recent studies on the impact of regional growth policies. In a general way, their results are not unanimous and lead to a non-significant or very small impact. In Section 3, we present the data which are original compared to other studies because they represent the five different objectives of structural funds and the Community initiatives over 1989–1999. We also introduce the spatial weight matrix and define the spatial effects that will be considered in the next section. Indeed, Section 4 estimates, first, the impact of each of the funds and of the total Community project cost. This includes investment efforts taking the form of additional funds by the region itself. Second, we estimate the impact of both the funds (Community project total cost) and their spatial lag on growth. Section 5 uses the same tools to focus on their impact on employment share in the labor force. Finally, Section 6 concludes this paper and gives some comments on the sector allocation of structural funds.

2. Literature Review

Two strands of literature provide insights into the effects of public assistance and infrastructures on regional growth and location of economic activity: growth models and economic geography models. In a neoclassical Solow growth model, re-

[1] See (Durlauf, Quah, 1999) for an extended review of this literature.

gional funds finance a greater level of physical capital, which corresponds to a higher steady state income. However, due to the decreasing marginal product of capital, the rate of investment declines towards the steady state income, where the stock of capital per person is constant. The investment rate is then equal to effective capital depreciation. Therefore, a higher investment rate in poorer regions may increase the convergence speed to rich regions, but is only transitional and does not raise the long-run growth rate. Conversely, endogenous growth theory grants public policies an important role in the determination of growth rates in the long run. For instance, Aschauer (1989) and Barro (1990) predict that if public infrastructures are an input in the production function, then policies financing new public infrastructures increase the marginal product of private capital, hence fostering capital accumulation and growth.

When such investments finance transportation infrastructures that yield a decrease in transportation costs, it may affect the process of industry location and favor agglomeration in rich regions. For example, Boarnet (1998) shows that highway projects in Californian counties benefit the investing counties at the expense of the other counties within the state. Kelejian and Robinson (1997) make similar arguments concerning externalities at the state level. However, the economic geography literature shows that transportation infrastructures do not systematically benefit the regions where they are implemented, more especially when they are used as regional development instruments (Vickerman, 1996), (Martin, Rogers, 1995), (Martin, 2000). In particular, with 30 % of structural funds devoted to transportation infrastructures, their impact on regional development has to be seen in the light of the characteristics of the transportation sector. The empirical study by Vickerman et al. (1999) points out that new transportation infrastructures tend to be built within or between rich regions, where the demand in this sector is the highest. Moreover, Puga and Venables (1997) show that in a transportation network based on hub-and-spoke interconnections, firms located in the hub face lower transaction costs in trading with firms in spoke locations than a firm in any spoke location trading with a firm in another spoke. As a consequence, this type of network promotes gains in accessibility in the hub location first (Puga, 2001;), (Venables, Gasiorek, 1999). The relationship between gain in accessibility and economic development in peripheral regions still requires considerable empirical investigation, especially given the variations in transportation demands by sector. It is stated however that gains in accessibility due to interregional transport infrastructures will always be relatively higher in the central location than in the peripheral ones (Vickerman et al., 1999). Therefore, transportation infra-structures cannot always be seen as an efficient instrument to reduce interregional disparities.

The role of the above discussion is to highlight the obvious creation of spatial externalities due to the implementation of regional funds and therefore the need to formally include spatial dependencies in our model. Of course, we clearly do not claim that all the regions have financed transportation infrastructures through regional funds (actually the sectoral allocation of these funds for each region is unknown) nor that they are the only type of public investments financed. Regional policy instruments are also devoted to improve either regional competitiveness as a whole or the incentives to locate at the level of each firm. Human capital formation or the improvement of infrastructures (in the transportation, telecommunications, energy and education sectors) belong to the first category whilst support to private capital investment through capital grants or tax breaks belongs to the latter one.

Many recent empirical studies have investigated the impact of regional funds on development. De la Fuente and Vives (1995) show that promoting education has significantly contributed to the reduction of per capita income inequalities among 17 regions of Spain between 1980 and 1991. Boldrin and Canova (2001) conclude that regional and structural policies mostly serve a redistributional purpose, but have little relationship to fostering economic growth. Rodriguez-Pose and Fratesi (2004) focus on different expenditure axes. They find no significant impact of funds devoted to infrastructures or to business support. Only investment in education and human capital has medium-term positive effects, whilst support for agriculture has short-term positive effects on growth. A large agricultural sector and lack of R&D are the two main reasons that hamper growth and regional development efforts in poor regions according to Cappelen et al. (2003). Finally, Midelfart-Knarvik and Overman (2002) find that European Structural Funds expenditure has an effect on the location of industry, notably by encouraging R&D-intensive industries to locate in countries and regions that have low endowments of skilled labor. As a result, these incentives have mostly been acting counter to states' comparative advantages and have not allowed poor regions to catch-up to the EU average.

More studies could be cited but this is not the topic of this paper, which, as noted earlier, pays special attention to the presence of spatial externalities induced by the implementation of regional funds, which is not the case of the papers cited above. For this purpose, we take spatial effects into account in the estimation of the impact of structural funds on the regional growth rate. These spatial effects are described in the next section.

3. Data and Weight Matrix

The data on per capita GDP and employment share in the labor force come from the Eurostat Regio database (2001). This is the official database used by the European Commission for its evaluation of regional convergence. The data on per capita structural funds come from three reports by the EU Commission (European Commission, 1992a, 1992b, 1999) and cover two programming periods: 1989–1993, 1994–1999. Data for 1994–1999 are the total payments plus the commitments taken during this period, but that have not been paid yet. The inexistence of more recent data leads us to assume that structural funds commitments and expenditures are strongly correlated. We are aware that this may create some problems, as considerable lags between the commitments and actual expenditure often take place. We consider the five objectives as well as the Community Initiatives which can be described as follows[2]:

– *Objective 1* funds were dedicated to the economic adaptation of the least developed regions and allocated to the NUTS 2[3] regions of which GDP per capita in PPS (Purchasing Power Standard) was below 75 % of the Community average.

– *Objective 2* funds were devoted to the economic recovery of regions affected by an industrial crisis.

– *Objective 3* funds tended to reduce long-term unemployment and improve the insertion of young people into working life.

[2] For a more detailed discussion on each objective, see (Dall'erba, 2003)

[3] Nomenclature of Territorial Units for Statistics. The European Commission divides its territory according to the classification established by Eurostat. It is based on national administrative units.

– *Objective 4* funds were targeted to facilitate the adaptation of workers and retraining focused on changes in industry changes and changes in the production process. Because of the data, (funds of Objectives 3 and 4) will be considered together.

– *Objective 5* funds were targeted to foster the adaptation of agricultural and fisheries structures within the framework of the reform of the Common Agricultural Policy.

– The Community Initiatives, which started in 1994, focus on various aspects of regional development, like interregional cooperation, employment, and economic restructuring.

In addition to the amount of structural funds, we also consider the total cost of Community projects for each objective, which equals the sum of structural funds and additional funds. Indeed, a particular project is never implemented without additional regional or national financing. This is the principle of additionality that would preclude regions presenting dubious projects.[4] This rule may introduce a bias due to the fact that poor regions often have difficulty matching European aid, whereas the aid can be tripled or quadrupled in regions with medium or high income levels, as they have more fiscal capacity to complement structural funds (Martin, 1998), (Dall'erba, 2004).

We consider 145 European regions at the NUTS II level: Belgium (11 regions), Denmark (1 region), Germany (30 regions; Berlin and the nine former East German regions are excluded due to historical reasons), Greece (13 regions), Spain (16 regions, as we exclude the remote islands: Las Palmas, Santa Cruz de Tenerife, Canary Islands, and Ceuta y Mellila), France (22 regions), Ireland (2 regions), Italy (20 regions), Netherlands (12 regions), Portugal (5 regions; the Azores and Madeira are excluded because of their geographical distance), Luxembourg (1 region), the United Kingdom (12 regions; we use regions at the NUTS I level, because NUTS II regions are not used as governmental units; they are merely statistical inventions of the EU Commission and the UK government).

The particular specification of the weights matrix, upon which all the estimations rely, depends on European geography, which does not allow us to consider simple contiguity matrices; otherwise the weights matrix would include rows and columns with only zeros for the islands. Since unconnected observations are eliminated from the results of spatial autocorrelation statistics, this would change the sample size and the interpretation of statistical inference. More precisely, we use the great circle distance between regional centroids. Distance and time-based weight matrices are defined as:

$$\begin{cases} w_{ij}^*(k) = 0 \text{ if } i = j, \forall k \\ w_{ij}^*(k) = 1/d_{ij}^2 \text{ if } d_{ij} \le D(k) \\ w_{ij}^*(k) = 0 \text{ if } d_{ij} > D(k) \end{cases} \quad \text{and} \quad w_{ij} = w_{ij}^* / \sum_j w_{ij}^* \quad \text{for } k = 1,...3 \qquad (1)$$

[4] Community funds support up to 75 % of total public expenditure in NUTS regions; the rest depends on national or regional additionality in order to avoid regions' present unviable projects. The ceilings vary according to the objective concerned: Objective 1 financed a maximum of 75 % of the total cost, but 80 % in cohesion countries (Spain, Portugal, Greece and Ireland) and 85 % in the most remote regions and the outlying Greek islands. The other objectives financed a maximum 50 % of the total cost.

where w_{ij}^* is an element of the unstandardized weight matrix; w_{ij} is an element of the standardized weight matrix; d_{ij} is the great circle distance (or time) between centroids of region i and j; $D(1) = Q1$, $D(2) = Me$ and $D(3) = Q3$, $Q1$, Me and $Q3$ are respectively the lower quartile, the median and the upper quartile of the great circle distance (or time) distribution. $D(k)$ is the cutoff parameter for $k = 1,...3$ above which interactions are assumed negligible. We use the inverse of the squared distance (time) in order to reflect a gravity function. Each matrix is row standardized so that it is the relative and not absolute distance (time) which matters.[5]

The weight matrices will allow us to detect and include the relevant spatial effects in the estimation of the impact of structural funds. These spatial effects take the form of spatial autocorrelation and/or spatial heterogeneity. The former refers to the coincidence of attribute similarity and locational similarity (Anselin, 1988, 2001). In our case, spatial autocorrelation means that rich regions tend to be geographically clustered, as are poor regions. The second spatial effect means that economic behaviors are not stable over space. This can be linked to the concept of convergence clubs, characterized by the possibility of multiple, locally stable, steady state equilibriums (Durlauf, Johnson, 1995).

4. Impact of Regional Support on the Convergence Process

Using the spatial weight matrices previously described, the first step of our analysis is to detect the existence of spatial heterogeneity in the distribution of regional per capita GDPs. For this purpose, we use the G-I* statistics developed by Ord and Getis (1995).[6] These statistics are computed for each region and they allow detecting the presence of local spatial autocorrelation: a positive value of this statistic for region i indicates a spatial cluster of high values, whereas a negative value indicates a spatial clustering of low values around region i. Based on these statistics, we determine our spatial regimes, which can be interpreted as spatial convergence clubs, using the following rule: if the statistic for region i is positive, then this region belongs to the group of "rich" regions and if the statistic for region i is negative, then this region belongs to the group of "poor" regions.

For all weight matrices described above two spatial regimes are persistent over the period and highlight some form of spatial heterogeneity:[7]

– 100 regions belong to the spatial regime "Core": Belgium, Germany, Denmark, France, Italy (except Molise, Campania, Puglia, Basilicata, Calabria, Sicilia), Luxembourg, the Netherlands, and the United Kingdom (except Northern Ireland, Scotland and North West),

– 45 regions belong to the spatial regime "Periphery": Spain, Greece, Ireland, Southern Italy (Molise, Campania, Puglia, Basilicata, Calabria, Sicily), Portugal, and the north of the United Kingdom (Northern Ireland, Scotland and North West).

[5] For comparison purposes, weight matrices based on the number of nearest neighbors are also generated.

[6] All computations in this section are carried out using the SpaceStat 1.91 software (Anselin, 1999).

[7] We do not define our regimes according to the results of the Moran scatterplot to avoid eliminating 9 regions of our sample.

The second step of our analysis consists in including both spatial effects in the estimation of the appropriate β-convergence model. In order to identify the form of the spatial dependence (spatial error model or spatial lag), the Lagrange Multiplier tests (resp. LMERR and LMLAG) and their robust version (resp. R-LMERR and R-LMLAG) are performed. The decision rule suggested by Anselin and Florax (1995)[8] leads us to a spatial error model. In addition, various tests aimed at detecting the presence of spatial effects, described in (Anselin, 1988), indicate the presence of spatial heterogeneity taking the form of groupwise heteroskedascticity and structural instability defined according to the spatial regimes previously defined. The form of the appropriate β-convergence model with structural funds is therefore the following:

$$\boldsymbol{g}_T = \alpha_C D_C + \beta_C D_C y_0 + \delta_C D_C \boldsymbol{FDS} + \alpha_P D_P + \beta_P D_P y_0 + \delta_P D_P FDS + \varepsilon$$

$$\text{with}\ldots\ \varepsilon = \lambda W\varepsilon + u \ \text{ and } \ u \sim N\left(0, \begin{bmatrix} \sigma^2_{\varepsilon,C} I_{100} & 0 \\ 0 & \sigma^2_{\varepsilon,P} I_{45} \end{bmatrix}\right) \tag{2}$$

where $\boldsymbol{g}_T$ is the (n×1) vector of average growth rates of per capita GDP between date 0 and T; $\boldsymbol{S}$ is the (n×1) sum vector; y_0 is the vector of log per capita GDP levels at date 0, $\boldsymbol{FDS}$ is the $(n\times 1)$ vector of per capita structural funds/total project cost and λ is a coefficient indicating the extent of spatial correlation between the residuals. D_C and D_P are dummy variables corresponding respectively to the core and periphery regimes previously defined; α_C, α_P, β_C, β_P, δ_C, δ_P are the unknown parameters to be estimated, and $\hat{\sigma}^2_\varepsilon$ represents the variance within each regime.

Estimation results by Maximum Likelihood are displayed in *Table 1*. They are confirmed by GMM estimation. The results indicate that there is significant convergence among the regions belonging to the periphery regime (p-value = 0.004) leading to a convergence speed of 3.55 and a half-life of 25.22 years.[9] On the other hand, the convergence coefficient in the core regime is not significant. The error term are significantly (p-value = 0.000) and spatially autocorrelated, which indicates that the growth rate of a region is significantly influenced by the growth rate of its surrounding regions. While none of the structural funds has a significant impact on the core regions, objectives 1 and 3&4 funds and the Community Initiatives have a significant but very small impact on the convergence process of the peripheral regions. We note that this impact is positive only for Community Initiatives, which may appear surprising when one knows the massive amount of Objective 1 funds that peripheral regions have benefited from over the study period. The same conclusions hold for the total cost of Community projects. The Chow test of overall stability rejects the joint null hypothesis on the equality of the regimes' coefficients, which is

[8] If LMLAG (resp. LMERR) is more significant than LMERR (resp. LMLAG) and R-LMLAG (resp. R-LMERR) is significant whereas R-LMERR (resp. R-LMLAG) is not, then the most appropriate model is the spatial autoregressive model (resp. the spatial error model).

[9] The convergence speed is the speed necessary for an economy to reach it steady-state. It may be defined as $b = -\ln(1 + T\beta)/T$. The half-life is the time necessary for an economy to fill half of the variation, which separates it from its steady-state, and is defined by $\tau = -\ln(2)/\ln(1+\beta)$.

TABLE 1 Impact of Structural Funds and Total Cost Project on the Convergence Process

	Structural funds		**Total cost**			**Struc. funds**	**Total cost**
	Core	**Periph.**	**Core**	**Periph.**		**Specification diagnostics**	
$\hat{\alpha}_{\gamma}$	0.009 (0.794)	0.297 (0.000)	0.017 (0.627)	0.290 (0.000)	Chow-Wald	24.508 (0.000)	27.572 (0.000)
$\hat{\beta}_{\gamma}$	0.003 (0.396)	-0.027 (0.004)	0.002 (0.516)	-0.026 (0.003)	Ind. stab. test on $\hat{\alpha}_{\gamma}$	9.899 (0.001)	9.737 (0.001)
Obj. 1	$5.03.10^{-6}$ (0.204)	$5.73.10^{-6}$ (0.002)	$9.78.10^{-7}$ (0.546)	$-3.54.10^{-6}$ (0.000)	Ind. stab. test on $\hat{\beta}_{\gamma}$	8.898 (0.002)	8.734 (0.003)
Obj. 2	$-2.01.10^{-6}$ (0.855)	$1.44.10^{-5}$ (0.572)	$-1.43.10^{-6}$ (0.699)	$3.85.10^{-6}$ (0.511)	Ind. stab. on Obj. 1	5.989 (0.014)	5.582 (0.018)
Obj. 3 and 4	$-6.45.10^{-6}$ (0.652)	$-7.20.10^{-5}$ (0.040)	$-4.33.10^{-6}$ (0.373)	$-4.62.10^{-5}$ (0.005)	Ind. stab. on Obj. 2	0.348 (0.554)	0.579 (0.446)
Obj. 5	$1.28.10^{-5}$ (0.208)	$7.92.10^{-7}$ (0.955)	$2.77.10^{-6}$ (0.333)	$6.58.10^{-9}$ (0.998)	Ind. stab. on Obj. 3&4	2.972 (0.084)	5.862 (0.015)
CI	$-3.14.10^{-5}$ (0.334)	$5.47.10^{-6}$ (0.017)	$-3.20.10^{-6}$ (0.748)	$3.75.10^{-5}$ (0.003)	Ind. stab. on Obj. 5	0.478 (0.488)	0.250 (0.616)
$\hat{\lambda}$	0.789 (0.000)		0.803 (0.000)		Ind. stab. on IC	4.668 (0.030)	6.333 (0.011)
$\hat{\sigma}^2_{\varepsilon,r}$	$4.25.10^{-5}$ (0.001)	$8.18.10^{-5}$ (0.008)	$4.27.10^{-5}$ (0.000)	$7.76.10^{-5}$ (0.000)	LR test on groupwise heteroske-dasticity	22.581 (0.000)	23.366 (0.000)
Conv. Speed	-	3.55 %	-	3.39 %			
Half--life	-	25.22	-	26.13			
Sq. Corr.	0.385		0.347				
LIK	509.259		510.167				
AIC	-990.519		-992.334				
SC	-948.844		-950.660				

Notes: *Sq. Corr.* is the squared correlation between predicted values and actual values. *LIK* is value of the maximum likelihood function. *AIC* is the Akaike information criterion. *SC* is the Schwarz information criterion. The individual coefficient stability tests are based on a spatially adjusted asymptotic Wald statistics, distributed as χ^2 with 1 degree of freedom. The Chow-Wald test of overall stability is also based on a spatially adjusted asymptotic Wald statistic, distributed as χ^2 with 2 degrees of freedom (Anselin,, 1988). *LR* is the likelihood ratio test for groupwise heteroskedasticity. *p*-values are in parentheses.

confirmed by the individual coefficient stability tests. The LR test confirms the presence of two significantly different variances across regimes.

The lack of significant impact of structural funds or total project cost on the regional convergence process is confirmed in *Table 2*, which shows the impact of total funds. We find again that peripheral regions are the only ones to converge with each other.

Since a significant part of regional funds are devoted to interregional infrastructures, as we have seen in Section 2, we test in a final step the impact of the funds and their spatial lags on the convergence process. The appropriate model is once again a model with spatial error dependence and spatial heterogeneity under the form of structural instability and groupwise heteroscedasticity. Estimation results, displayed in *Table 3*, indicate the presence of significant convergence only within the peripheral regime. With regard to the regional funds, only Objective 3 and 4, Community Initiatives and the lag of Objective 2 funds have a significant, but small, im-

TABLE 2 Impact of Total Structural Funds and Total Cost Project on The Convergence Process

	Structural funds		Total cost			Struc funds	Total cost
	Core	Periph.	Core	Periph.		Specification diagnostics	
$\hat{\alpha}_\gamma$	0.019 (0.575)	0.358 (0.000)	0.021 (0.544)	0.351 (0.000)	Chow-Wald	16.626 (0.000)	15.971 (0.001)
$\hat{\beta}_\gamma$	0.002 (0.566)	-0.033 (0.000)	0.001 (0.592)	-0.033 (0.000)	Ind. stab. test on $\hat{\alpha}_\gamma$	14.697 (0.000)	13.871 (0.000)
Funds	$-1.00.10^{-7}$ (0.959)	$-1.82.10^{-6}$ (0.126)	$-1.39.10^{-7}$ (0.842)	$-7.78.10^{-7}$ (0.186)	Ind. stab. on $\hat{\beta}_\gamma$	13.742 (0.000)	12.980 (0.009)
$\hat{\lambda}$	0.777 (0.000)		0.774 (0.000)		Ind. stab. on funds	0.553 (0.456)	0.487 (0.485)
$\hat{\sigma}^2_{\varepsilon,r}$	$4.37.10^{-5}$ (0.001)	$9.72.10^{-5}$	$4.37.10^{-5}$ (0.000)	$9.86.10^{-5}$ (0.000)	LR test on groupwise heteroskedasticity	26.960 (0.000)	27.253 (0.000)
Conv. Speed	-	4.88 %	-	4.71 %			
Half-life	-	20.08	-	20.57			
Sq. Corr.	0.325		0.326				
LIK	503.995		503.694				
AIC	-995.990		-995.388				
SC	-978.129		-977.528				

Note: See notes for Table 1.

pact on peripheral regions, whereas core regions seem affected by the lag of Objective 5 funds only. With regard to the total project cost, peripheral regions are affected by the same funds as previously plus Objective 2 and the lag of Objective 1 funds. In the case of structural funds and total project cost, the results indicate that the lags have a more important impact than the funds allocated to the region itself. This may be due to the fact that they represent a much greater amount. Finally, we note that the lag of Objective 5 is still the only fund to impact the core regions' growth.

The larger and more significant impact of the lags is confirmed when studying the impact of total funds. Indeed, *Table 4* shows that while peripheral regions are the only ones to converge, the lag of structural funds or the lag of total project cost have a significant impact on their convergence process. These last results maintain some credibility in the necessity for regional assistance compared to the results of the previous tables.

5. Impact of Regional Support on Employment

Per capita GDP regional growth is not the only purpose of regional assistance. Indeed, while Objective 3 and 4 funds as well as some Community Initiatives clearly have the objective of reducing unemployment, Objective 2 funds may also correspond to this idea. In the case of employment share in the labor force, the tools described in the previous section enable the appearance of two spatial regimes:

– 101 regions belong to the "North-West" spatial regime with a high employment share: Belgium, Germany, Denmark, the East of France (i.e. France with

TABLE 3 Impact of Structural Funds and Total Project Cost, and Their Respective Lags on the Convergence Process

	Structural funds		**Total cost**			**Struc. Funds**	**Total cost**
	Core	**Periph.**	**Core**	**Periph.**		**Specif. diagnostics**	
$\hat{\alpha}_{\gamma}$	0.026 (0.474)	0.273 (0.000)	0.029 (0.424)	0.258 (0.000)	Chow-Wald	40.258 (0.000)	47.504 (0.000)
$\hat{\beta}_{\gamma}$	0.001 (0.750)	-0.025 (0.002)	0.001 (0.785)	-0.024 (0.001)	Ind. stab. test on $\hat{\alpha}_{\gamma}$	8.929 (0.002)	8.708 (0.003)
Obj. 1	$4.76.10^{-6}$ (0.269)	$-3.71.10^{-6}$ (0.108)	6.60.10 (0.700)	$-9.77.10^{-7}$ (0.404)	Ind. stab. test on $\hat{\beta}_{\gamma}$	8.795 (0.003)	8.836 (0.002)
Obj. 2	$-1.31.10^{-6}$ (0.905)	$5.02.10^{-5}$ (0.094)	$1.14.10^{-6}$ (0.764)	$1.58.10^{-5}$ (0.015)	Ind. stab. on Obj. 1	3.001 (0.083)	0.619 (0.431)
Obj. 3&4	$-4.74.10^{-6}$ (0.760)	$-1.00.10^{-4}$ (0.007)	$-3.62.10^{-6}$ (0.505)	$-6.36.10^{-5}$ (0.000)	Ind. stab. on Obj. 2	2.595 (0.107)	5.042 (0.024)
Obj. 5	$1.39.10^{-6}$ (0.196)	$-1.21.10^{-6}$ (0.387)	$3.42.10^{-6}$ (0.261)	$6.88.10^{-6}$ (0.134)	Ind. stab. on Obj. 3 and 4	5.600 (0.017)	9.166 (0.002)
CI	$-5.99.10^{-5}$ (0.099)	$6.98.10^{-5}$ (0.001)	$-1.31.10^{-5}$ (0.248)	$3.63.10^{-5}$ (0.007)	Ind. stab. on Obj. 5	2.171 (0.140)	3.488 (0.061)
L_Obj. 1	-0.007 (0.523)	0.001 (0.826)	-0.002 (0.739)	0.017 (0.015)	Ind. stab. on CI	9.267 (0.002)	7.765 (0.005)
L_Obj. 2	0.002 (0.321)	0.009 (0.052)	0.001 (0.764)	0.015 (0.002)	Ind. stab. on L_Obj. 1	0.429 (0.512)	3.078 (0.079)
L_Obj. 3&4	0.001 (0.763)	-0.010 (0.225)	0.002 (0.379)	0.003 (0.806)	Ind. stab. on L_Obj. 2	1.386 (0.239)	5.118 (0.023)
L_Obj. 5	-0.008 (0.016)	$0.74.10^{-3}$ (0.889)	-0.007 (0.030)	-0.004 (0.408)	Ind. stab. on L_Obj. 3&4	1.514 (0.218)	$0.16.10^{-4}$ (0.996)
L_CI	0.002 (0.804)	0.007 (0.145)	$-6.01.10^{-4}$ (0.909)	-0.004 (0.518)	Ind. stab. on L_Obj. 5	1.857 (0.172)	0.132 (0.716)
$\hat{\lambda}$	0.567 (0.000)		0.619 (0.000)		Ind. stab. on L_CI	0.295 (0.586)	0.191 (0.661)
$\hat{\sigma}^2_{\varepsilon,r}$	$4.25.10^{-5}$ (0.000)	$6.90.10^{-5}$ (0.000)	$4.35.10^{-5}$ (0.000)	$5.80.10^{-5}$ (0.000)	LR test on groupwise heteroscedasticity	9.534 (0.008)	8.416 (0.014)
Conv. Speed	-	3.30 %	-	3.06 %			
Half-life	-	26.68	-	28.23			
Sq. Corr.	0.630		0.617				
LIK	513.069		515.852				
AIC	-978.138		-983.703				
SC	-906.696		-912.262				

Note: See notes for *Table 1*.

the exception of Pays de la Loire, Bretagne, Poitou Charentes, Aquitaine, Midi-Pyrénées, Limousin, Auvergne, Languedoc Roussillon), Northern Italy (i.e. Italy with the exception of Lazzio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily, Sardinia), Luxembourg, the Netherlands, the United Kingdom (except Wales, Northern Ireland, Scotland and North West), and Greece.

– 44 regions belong to the spatial regime "South-East" with a low employment share: Spain, Portugal, Ireland, Southern Italy (Lazzio, Abruzzo, Molise, Campania, Puglia, Basilicata, Calabria, Sicily, Sardinia), the West of France (Pays de la Loire, Bretagne, Poitou Charentes, Aquitaine, Midi-Pyrénées, Limousin, Auvergne, Languedoc-Roussillon), the North of the United Kingdom (Wales, Northern Ireland, Scotland and North West).

TABLE 4 Impact of Total Structural Funds, Total Project Cost and Their Respective Lags on the Convergence Process

	Structural funds		Total cost			Struc. Funds	Total cost
	Core	Periph.	Core	Periph.		Specif. diagnostics	
$\hat{\alpha}_{\gamma}$	0.021 (0.540)	0.311 (0.000)	0.024 (0.479)	0.308 (0.000)	Chow-Wald	14.871 (0.004)	16.771 (0.002)
$\hat{\beta}_{\gamma}$	0.001 (0.631)	-0.029 (0.000)	0.001 (0.695)	-0.029 (0.000)	Ind. stab. test on $\hat{\alpha}_{\gamma}$	11.358 (0.000)	11.279 (0.000)
Funds	$-4.15.10^{-7}$ (0.841)	$-1.70.10^{-7}$ (0.899)	$-3.04.10^{-7}$ (0.683)	$8.48.10^{-8}$ (0.896)	Ind. stab. test on $\hat{\beta}_{\gamma}$	11.301 (0.000)	11.262 (0.009)
L_Funds	-0.002 (0.682)	0.007 (0.018)	-0.002 (0.609)	0.007 (0.008)	Ind. stab. on funds	0.009 (0.921)	0.154 (0.694)
$\hat{\lambda}$	0.742 (0.000)		0.728 (0.000)		Ind. stab. on L_Funds	2.018 (0.155)	3.247 (0.071)
$\hat{\sigma}^2_{\varepsilon,r}$	$4.39.10^{-5}$ (0.000)	$9.11.10^{-5}$ (0.000)	$4.40.10^{-5}$ (0.000)	$9.10.10^{-5}$ (0.000)	LR test on groupwise hete-roscedasticity	18.991 (0.000)	17.798 (0.000)
Conv. Speed	-	4.02 %	-	3.99 %			
Half-life	-	22.98	-	23.12			
Sq. Corr.	0.403		0.425				
LIK	505.169		505.068				
AIC	-994.339		-994.136				
SC	-970.525		-970.322				

Note: See notes for Table 1.

TABLE 5 Impact of Structural Funds and Total Cost Project on Employment

	Structural funds		Total cost			Struc. Funds	Total cost
	N-E	S-W	N-E	S-W		Specif. diagnostics	
$\hat{\alpha}_{r}$	0.003 (0.932)	0.006 (0.794)	0.001 (0.968)	0.006 (0.789)	Chow-Wald	14.095 (0.049)	13.544 (0.059)
$\hat{\beta}_{\gamma}$	-0.001 (0.928)	-0.002 (0.718)	$-4.61.10^{-4}$ (0.965)	-0.001 (0.711)	Ind. stab. test on $\hat{\alpha}_{r}$	0.002 (0.958)	0.007 (0.933)
Obj. 1	$-5.13.10^{-7}$ (0.246)	$1.01.10^{-6}$ (0.140)	$-2.15.10^{-7}$ (0.263)	$6.40.10^{-7}$ (0.060)	Ind. stab. test on $\hat{\beta}_{r}$	0.009 (0.921)	0.016 (0.899)
Obj. 2	$-5.91.10^{-7}$ (0.876)	$1.63.10^{-5}$ (0.000)	$-1.11.10^{-7}$ (0.934)	$4.16.10^{-6}$ (0.000)	Ind. stab. on Obj. 1	3.516 (0.060)	4.787 (0.028)
Obj. 3 and 4	$-3.53.10^{-7}$ (0.918)	$7.73.10^{-5}$ (0.328)	$-1.41.10^{-8}$ (0.990)	$4.89.10^{-6}$ (0.217)	Ind. stab. on Obj. 2	7.860 (0.005)	5.586 (0.018)
Obj. 5	$1.03.10^{-6}$ (0.744)	$1.14.10^{-6}$ (0.699)	$4.96.10^{-7}$ (0.606)	$-5.12.10^{-7}$ (0.618)	Ind. stab. on Obj. 3 and 4	0.875 (0.349)	1.394 (0.237)
CI	$2.14.10^{-6}$ (0.753)	$7.90.10^{-7}$ (0.897)	$7.73.10^{-8}$ (0.978)	$1.88.10^{-6}$ (0.561)	Ind. stab. on Obj. 5	0.251 (0.616)	0.512 (0.473)
$\hat{\rho}$	0.806 (0.000)		0.815 (0.000)		Ind. stab. on CI	0.021 (0.883)	0.206 (0.649)
Conv. Speed	-	-	-	-	BP Test	2.178 (0.139)	2.276 (0.131)
Half-life	-	-	-	-	Spatial BP Test	2.178 (0.139)	2.276 (0.131)
Sq. Corr.	0.657		0.659				
LIK	675.317		675.258		LR test on spatial lag dependence	67.862 (0.000)	75.144 (0.000)
AIC	-1320.63		-1320.52				
SC	-1275.98		-1275.86		LM test on spatial error dependence	2.158 (0.141)	2.276 (0.131)

Note: See notes for Table 1.

TABLE 6 Impact of Total Structural Funds and Total Cost Project on Employment

	Structural funds		Total cost			Structural funds	Total cost
$\hat{\alpha}_r$	0.005 (0.763)		0.004 (0.783)			Specification diagnostics	
$\hat{\beta}_r$	-0.001 (0.757)		-0.001 (0.776)		LR-test on group. heterosk.		
Funds	$-3.94.10^{-8}$ (0.808)		$-8.61.10^{-9}$ (0.917)				
$\hat{\rho}$	0.865 (0.000)		0.867 (0.000)				
$\hat{\sigma}^2_{\varepsilon,r}$	$4.11.10^{-6}$ (0.000)	$7.64.10^{-6}$ (0.000)	$4.11.10^{-6}$ (0.000)	$7.61.10^{-6}$ (0.000)			
Conv. Speed	-	-	-	-			
Half-life	-	-	-	-			
Sq. Corr.	0.634		0.635				
LIK	669.229		669.207				
AIC	-1330.46		-1330.41				
SC	-1318.55		-1318.51				

Note: See notes for Table 1.

In the case of employment share, the appropriate β-convergence model is a spatial lag model with structural instability as follows:

$$g_T = \lambda W g_T + \alpha_C D_C + \beta_C D_C y_0 + \delta_C D_C FDS + \alpha_P D_P + \beta_P D_P y_0 + \delta_P D_P FDS + \varepsilon$$

with $\varepsilon \sim N(0, \sigma_u^2 I)$ (3)

Estimation results by Maximum Likelihood are displayed in *Table 5*.[10] On the opposite of the previous section, we do not detect any significant convergence of employment growth among regimes. The spatial lag coefficient is significant (p-value = 0.000) which means that the growth rate of employment in one region is positively and significantly determined by the one of its neighbors. Only the impact of Objective 2 funds in South-Western regions employment is significant.

When estimating the impact of total funds on employment, the results displayed in *Table 6* do not indicate any significant coefficient, except the one on the spatial lag dependence and the regimes' variance. We also note that spatial heterogeneity takes the form of groupwise heteroskedascticity in this case.

When we include the spatial lag of the funds, the results of *Table 7* indicate that several objectives and their lag act significantly on regional employment. In the case of the South-Western regions, Objective 1, 2, and the lag of Objective 1, 3 and 4, 5 (to some extent) and of Community Initiatives have a significant impact on employment. The same funds (except Objective 2 funds and the lag of CI) impact significantly on the North-Eastern regions. As in the previous section, the extent of the impact of the lag is greater than the one of the funds allocated to the region itself. We reach the same conclusions for the total project cost with the exception that none of the funds lag is significant in the South-Western regions.

Finally, the results in *Table 8* indicate neither significant impact of total funds nor their lag on employment growth. We do not detect the presence of spatial regimes and the spatial lag is significant, like in *table 6*.

[10] Results are confirmed by Instrumental Variables estimation.

TABLE 7 Impact of Structural Funds, Total Project Cost and Their Respective Lags on Employment

	Structural funds		Total cost			Struc. funds	Total cost
	N-E	S-W	N-E	S-W		Specif. diagnostics	
$\hat{\alpha}_r$	-0.032 (0.479)	0.002 (0.942)	-0.044 (0.377)	0.003 (0.897)	Chow-Wald	33.460 (0.000)	25.463 (0.012)
$\hat{\beta}_r$	0.007 (0.480)	-0.001 (0.851)	0.009 (0.337)	-0.001 (0.803)	Ind. stab. test on $\hat{\alpha}_r$	0.424 (0.514)	0.713 (0.398)
Obj. 1	$-1.12.10^{-6}$ (0.070)	$1.49.10^{-6}$ (0.041)	$-5.59.10^{-7}$ (0.052)	$9.72.10^{-7}$ (0.009)	Ind. stab. test on $\hat{\beta}_r$	0.495 (0.481)	0.805 (0.369)
Obj. 2	$-4.17.10^{-7}$ (0.912)	$1.23.10^{-5}$ (0.030)	$1.52.10^{-8}$ (0.991)	$3.85.10^{-6}$ (0.007)	Ind. stab. on Obj. 1	7.418 (0.006)	10.628 (0.001)
Obj. 3 and 4	$-2.95.10^{-6}$ (0.393)	$9.67.10^{-6}$ (0.271)	$-3.70.10^{-7}$ (0.778)	$5.96.10^{-6}$ (0.145)	Ind. stab. on Obj. 2	3.470 (0.062)	3.638 (0.056)
Obj. 5	$5.90.10^{-6}$ (0.082)	$-1.42.10^{-6}$ (0.621)	$1.89.10^{-6}$ (0.078)	$-2.58.10^{-7}$ (0.801)	Ind. stab. on Obj. 3 and 4	1.783 (0.181)	2.164 (0.141)
CI	$-6.21.10^{-7}$ (0.922)	$-6.18.10^{-6}$ (0.359)	$-1.53.10^{-6}$ (0.580)	$-6.20.10^{-6}$ (0.097)	Ind. stab. on Obj. 5	2.705 (0.099)	2.093 (0.147)
L_Obj. 1	0.002 (0.075)	-0.004 (0.005)	0.002 (0.040)	$-7.04.10^{-5}$ (0.951)	Ind. stab. on CI	0.357 (0.549)	1.008 (0.315)
L_Obj. 2	$-2.11.10^{-5}$ (0.976)	0.001 (0.385)	$-2.53.10^{-4}$ (0.775)	0.001 (0.168)	Ind. stab. on L_Obj. 1	10.759 (0.001)	2.003 (0.157)
L_Obj. 3 and 4	0.002 (0.005)	-0.004 (0.001)	0.002 (0.006)	-0.001 (0.308)	Ind. stab. on L_Obj. 2	0.574 (0.448)	1.603 (0.205)
L_Obj. 5	-0.002 (0.023)	0.001 (0.062)	-0.002 (0.065)	$5.44.10^{-5}$ (0.949)	Ind. stab. on L_Obj. 3 and 4	17.031 (0.000)	5.650 (0.017)
L_CI	$-7.67.10^{-4}$ (0.674)	0.004 (0.000)	$-4.53.10^{-4}$ (0.766)	0.001 (0.335)	Ind. stab. on L_Obj. 5	8.537 (0.003)	2.177 (0.140)
$\hat{\rho}$	0.718 (0.000)		0.769 (0.000)		Ind. stab. on L_CI	5.226 (0.022)	0.633 (0.425)
Conv. Speed	-	-	-	-	BP Test	0.252 (0.615)	2.824 (0.093)
Half-life	-	-	-	-	Spatial BP Test	0.252 (0.615)	2.828 (0.092)
Sq. Corr.	0.703		0.689				
LIK	688.997		683.948		LR test on spatial lag dependence	40.342 (0.000)	51.297 (0.000)
AIC	-1327.99		-1317.90				
SC	-1253.58		-1243.48		LM test on spatial error dependence	1.191 (0.275)	2.298 (0.129)

Note: See notes for Table 1.

6. Conclusion

This paper has highlighted the importance of including spatial effects when studying the impact of regional funds on regional growth or employment. Indeed, regional funds finance interregional infrastructures, mainly devoted to reduce transportation costs, which create spatial dependence among regions. Estimation results that we have performed on the β-convergence model have shown that per capita GDP growth and employment growth of each region is positively and significantly affected by the growth level of its neighboring regions. In addition, we have paid special

TABLE 8 Impact of Total Structural Funds, Total Project Costs and Their Lags on Employment

	Structural funds		Total cost			Struct. funds	Total cost
$\hat{\alpha}_r$	0.007 (0.693)		0.005 (0.764)			Specification diagnostics	
$\hat{\beta}_r$	-0.001 (0.683)		-0.001 (0.757)		LR test on group. heterosk.	5.559 (0.018)	5.826 (0.015)
Funds	$5.69.10^{-8}$ (0.819)		$1.08.10^{-9}$ (0.992)				
L_Funds	$-1.97.10^{-4}$ (0.602)		$-4.69.10^{-5}$ (0.899)				
$\hat{\rho}$	0.860 (0.000)		0.866 (0.000)				
$\hat{\sigma}^2_{\varepsilon,r}$	$4.14.10^{-6}$ (0.000)	$7.53.10^{-6}$ (0.000)	$4.12.10^{-6}$ (0.000)	$7.59.10^{-6}$ (0.000)			
Conv. Speed	-	-	-	-			
Half-life	-	-	-	-			
Sq. Corr.	0.634		0.635				
LIK	669.356		669.215				
AIC	-1328.71		-1328.43				
SC	-1313.83		-1313.55				

Note: See notes for Table 1.

attention to the role played by each of the five objectives of structural funds over 1989–1999 and by additional funds financed by regional or national authorities. First, the results have indicated for both variables that the growth process is different between core and peripheral regions. In the case of employment, the divide takes the form of North-East versus South-West patterns. It also means that the impact of structural funds may differ according to the regime the assisted region belongs to.

When looking at the impact of funds on the convergence process, the core regions do not seem to be affected by regional assistance. Peripheral regions are significantly but very little affected by some structural funds (objectives 1 and 3 and 4 funds and Community Initiatives). The same conclusions hold for the Community projects total cost. When we add the lag of each fund as an explanatory variable, peripheral regions are affected by objective 3 and 4, Community Initiatives and the lag of Objective 2 funds while core regions are affected by Objective 5 funds only. The lag of Objective 1 funds also affects peripheral regions in the case of total project cost. This last result may reflect some "bias" introduced by additional funds. We note also that the significant impact of the lags is always greater than the one of the funds allocated to the region itself. Peripheral regions seem therefore more affected by the funds received by their neighbors, as is highlighted in the estimation of the impact of total funds.

Finally, since regional funds are also devoted to support regional employment, we have estimated the impact of funds on the growth of this variable. Results show that Objective 2 funds are the only one to impact significantly South-Western regions (initially low employment regions). Including the lag of the funds indicate the significant impact of Objective 1, 2, and the lag of objective 1, 3 and 4, 5 (to some extent) and of Community Initiatives on these regions' employment. The same funds (except Objective 2 funds and the lag of CI) impact significantly the North-Eastern regions (initially high employment regions). All in all, these results do not show a significant impact of structural funds nor total project cost on regional per capita GDP or employment growth. While objective 1 funds are supposed to enhance the development level of peripheral regions and objective 3 and 4 funds the employment level in low employment regions, we dot not necessarily find a significant impact of these funds on their designated objective. When the impact is significant, its extent is pretty low or, sometimes, negative. These results raise some doubts about the efficiency of regional assistance over 1989–1999 and call for a deep reform for the new programming period.

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